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EVALUATION OF THE VISUAL SIGNALLER DEVELOPED FOR THE 82D AIRBOR--ETC(U)
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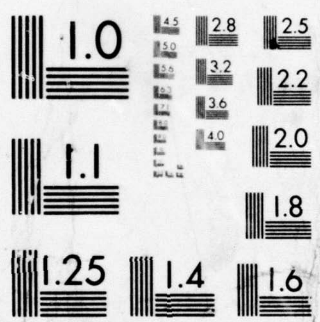
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NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0307-77

EVALUATION OF THE VISUAL SIGNALLER DEVELOPED FOR THE 82d AIRBORNE DIVISION

SEPTEMBER-OCTOBER 1976

SERVING THE ARMY IN ITS PREVENTIVE MEDICINE PROGRAM

SENTINEL of HEALTH

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US ARMY
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A laser radiation protection special study of the visual signallers constructed for the 82d Airborne Division by Harry Diamond Laboratories was conducted by this Agency on 16 September and 26 October 1976.

Radiometric measurements indicated that these signallers are Class II helium-neon laser products and therefore do not pose a momentary viewing hazard.

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

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NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0307-77 EVALUATION OF THE VISUAL SIGNALLER DEVELOPED FOR THE 82d AIRBORNE DIVISION SEPTEMBER-OCTOBER 1976

ABSTRACT

A laser radiation protection special study of the visual signallers constructed for the 82d Airborne Division by Harry Diamond Laboratories was conducted by this Agency on 16 September and 26 October 1976.

Radiometric measurements indicated that these signallers are Class II helium-neon laser products and therefore do not pose a momentary viewing hazard. It is recommended that unprotected personnel not be permitted to continually stare into the beam within 360 m of the laser or 4.6 km when viewing through optical instruments.

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

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NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 42-0307-77
EVALUATION OF THE VISUAL SIGNALLER DEVELOPED FOR THE 82d AIRBORNE DIVISION
SEPTEMBER-OCTOBER 1976

1. AUTHORITY.

a. AR 40-5, Health and Environment, 25 September 1974.

b. Letter, DRXDO-ASD, Harry Diamond Laboratories, 11 August 1976. subject: Safety Evaluation of Helium-Neon Laser Signalling and Beacon Devices, and indorsements thereto.

2. REFERENCES.

a. AR 10-5, Organization and Functions, Department of the Army, 1 April 1975.

b. AR 40-46, Control of Health Hazards from Lasers and Other High Intensity Optical Sources, 6 February 1974.

c. TB MED 279, Control of Hazards to Health from Laser Radiation, 30 May 1975.

d. Letter, HSE-RL, this Agency, 16 September 1976, subject: Preliminary Hazard Analysis of Laser Instrumentation Beacon Developed for Operational Test and Evaluation Agency (OTEA).

3. PURPOSE. To evaluate potential health hazards associated with the use of the visual signaller developed for the 82d Airborne Division and to make recommendations designed to limit exposure of personnel to potentially hazardous radiation from this device.

4. GENERAL.

a. Background. The Electro-Optics Systems Branch of the Harry Diamond Laboratories constructed several visual signallers for the 82d Airborne Division. The systems each consisted of the Metrologic model 620 helium-neon laser mounted on simple camera tripods. These devices are equipped with an electro-optic shutter such that the output beam can be coded by a telegraph key. The signaller was designed to communicate with an observer located between 0.4 to 10 km from the device.

b. Inventory. Two units were constructed by Harry Diamond Laboratories at the time of this study. These signallers were delivered to Fort Bragg on 28 October 1976.

c. Instrumentation.

(1) EG&G Model 580 Radiometer System with Model 22A Detector Head.

(2) United Detector Technology Model 40X Optometer.

(3) Scientech Model 362 Disk Calorimeter.

(4) Tektronix Model 7633 Storage Oscilloscope.

d. Radiometric Terms and Units. The Appendix provides a table of the radiometric terms and units utilized in this report.

5. FINDINGS.

a. Laser Parameters. Eight Metrologic model 620 helium-neon lasers were measured on 16 September 1976 at the US Army Environmental Hygiene Agency. These lasers were used to construct laser instrumentation beacons for OTEA (see paragraph 2d). This type of laser was also used for the visual signaller. Additional measurements were made upon one signaller laser at Harry Diamond Laboratories on 26 October 1976. The following output parameters were obtained:

(1) Wavelength: 632.8 nm.

(2) Radiant Power: The continuous output power was between 0.51 mW and 0.97 mW.

(3) Duty Cycle: Estimated at 50 percent or less.

(4) Laser Classification: Class II, low power lasers.

(5) Emergent Beam Diameter: Approximately 0.12 cm.

(6) Effective Beam Divergence: 1 mrad at 1/e-peak-irradiance-points measured (1.4 mrad at 90 percent power specified).

(7) Polarization: Random.

b. System Safety. A mechanical beam shutter was present on the completed units. A Class II warning label was present on the lasers as supplied by Metrologic. The signallers will be tripod mounted for stable pointing of the beam.

6. DISCUSSION.

a. Protection Standards. The potential hazard from the visual signallers is limited to the unprotected eyes of individuals staring into the beam for periods greater than 0.25 s at close range. The protection standards for momentary viewing of a continuous visible laser is 1 mW through a 7-mm pupillary aperture within the blink response of the eye. Since none of the lasers exceeded 1 mW, they do not pose a momentary viewing hazard. Long-term purposeful staring into the beam (to 8 hours) reduces the permissible level to 1 $\mu W/cm^2$ averaged over a 7-mm aperture. Beyond 360 m from the laser the irradiance was below 1 $\mu W/cm^2$ for intrabeam viewing without an optical instrument. Viewing the beam through 13-power optics would theoretically extend this caution range to about 4.6 km. The signallers are not intended to be used for periods sufficient to generate a concern over long-term staring at the source.

b. Other Standards. The signallers conform with the Bureau of Radiological Health laser performance standards [Title 21, Code of Federal Regulations (CFR), 1976 ed., Part 1040, Performance Standards for Light-Emitting Products].

7. CONCLUSION. The visual signallers emit optical radiation exceeding current protection standards. However, these devices may be operated safely provided that the operators are informed of the potential hazards and take appropriate precautions.

8. *RECOMMENDATIONS*.

a. Do not permit unprotected personnel to intentionally (continuously for periods in excess of 3 hours) stare into the beam within 360 m of the laser (or 4.6 km through optical instruments). Momentary viewing is not considered hazardous even through optical instruments (paragraph 1-4a of AR 40-46).

b. Do not permit unprotected personnel to intentionally stare at the laser (intrabeam viewing) for periods exceeding 15 minutes at distances exceeding 100 m (or 1.5 km through optical instruments) (paragraph 1-4a of AR 40-46).

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APPENDIX

USEFUL CIE RADIOMETRIC AND PHOTOMETRIC TERMS AND UNITS[1,2]

RADIOMETRIC				PHOTOMETRIC			
Term	Symbol	Defining Equation	SI Unit and Abbreviation	Term	Symbol	Defining Equation	SI Units and Abbreviation
Radiant Energy	Q_e		Joule (J)	Quantity of Light	Q_v	$Q_v = \int \Phi_v dt$	lumen-second (lm·s) (talbot)
Radiant Energy Density	W_e	$W_e = \frac{dQ_e}{dV}$	Joule per cubic meter ($J\cdot m^{-3}$)	Luminous Energy Density	W_v	$W_v = \frac{dQ_v}{dV}$	talbot per square meter ($lm\cdot s\cdot m^{-3}$)
Radiant Power (Radiant Flux)	Φ_e, P	$\Phi_e = \frac{dQ_e}{dt}$	Watt (W)	Luminous Flux	Φ_v	$\Phi_v = 680 \int \frac{d\Phi_e}{d\lambda} V(\lambda)\, d\lambda$	lumen (lm)
Radiant Exitance	M_e	$M_e = \frac{d\Phi_e}{dA} = \int L_e \cdot \cos\theta \cdot d\Omega$	Watt per square meter ($W\cdot m^{-2}$)	Luminous Exitance	M_v	$M_v = \frac{d\Phi_v}{dA} = \int L_v \cdot \cos\theta \cdot d\Omega$	lumen per square meter $lm\cdot m^{-2}$
Irradiance or Radiant Flux Density (Dose Rate in Photobiology)	E_e	$E_e = \frac{d\Phi_e}{dA}$	Watt per square meter ($W\cdot m^{-2}$)	Illuminance (luminous flux density)	E_v	$E_v = \frac{d\Phi_v}{dA}$	lumen per square meter ($lm\cdot m^{-2}$) lux (lx)
Radiant Intensity	I_e	$I_e = \frac{d\Phi_e}{d\Omega}$	Watt per steradian ($W\cdot sr^{-1}$)	Luminous Intensity (candlepower)	I_v	$I_v = \frac{d\Phi_v}{dr}$	lumen per steradian ($lm\cdot sr$) or candela (cd)
Radiance	L_e	$L_e = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	Watt per steradian and per square meter ($W\cdot sr^{-1}\cdot m^{-2}$)	Luminance	L_v	$L_v = \frac{d^2\Phi_e}{dr \cdot dA \cdot \cos\theta}$ [5]	candela per square meter ($cd\cdot m^{-1}$)
Radiant Exposure (Dose, in Photobiology)	H_e	$H_e = \frac{dQ_e}{dA}$	Joule per square meter ($J\cdot m^{-2}$)	Light Exposure	H_v	$H_v = \frac{dQ_v}{dA} = \int E_v dt$	lux-second (lx·s)
				Luminous Efficacy (of radiation)	K	$K = \frac{\Phi_v}{\Phi_e}$	lumen per watt ($lm\cdot W^{-1}$)
				Luminous Efficiency (of a broad band radiation)	V(*)	$V(*) = \frac{K}{K_m} = \frac{K}{680}$	unitless
Radiant Efficiency [3] (of a source)	η_e	$\eta_e = \frac{P}{P_i}$	unitless	Luminous Efficacy[3] (of a source)	η_v	$\eta_v = \frac{\Phi_v}{P_i}$	lumen per watt ($lm\cdot W^{-1}$)
Optical Density [4]	D_e	$D_e = -\log_{10} \tau_e$	unitless	Optical Density[4]	D_v	$D_v = -\log_{10} \tau_v$	unitless
				Retinal Illuminance in Trolands	E_t	$E_t = \frac{L_v}{S_p}$	troland (td) = luminance in $cd\cdot m^{-2}$ times pupil area in mm^2

1. The units may be altered to refer to narrow spectral bands in which case the term is preceded by the word *spectral*, and the unit is then per wavelength interval and the symbol has a subscript λ. For example, spectral irradiance H_λ has units of $W\cdot m^{-2}\cdot m^{-1}$ or more often, $W\cdot cm^{-2}\cdot nm^{-1}$.

2. While the meter is the preferred unit of length, the centimeter is still the most commonly used unit of length for many of the above terms and the nm or μm are most commonly used to express wavelength.

3. P_i is electrical input power in watts. 4. τ is the transmission

5. At the source $L = \frac{dI}{dA \cdot \cos\theta}$ and at a receptor $L = \frac{dE}{d\Omega}$